Develop and apply methods for assessing fire safety in nuclear facilities

RES/DRA

The development of risk-informed, performance-based fire standards and regulations requires a sound understanding of fire phenomena and its contribution to overall nuclear power plant (NPP) risk. A fire research program has been developed and is being implemented to address the complex issues associated with fire risk and fire modeling to support risk-informed changes to these standards and regulations. The Office of Nuclear Regulatory Research (RES) is performing specialized testing to support other NRC program offices.

The staff worked with the National Fire Protection Association (NFPA) to develop a performance-based, risk-informed fire protection standard (NFPA 805) for nuclear power plants. NFPA 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," was issued in January 2001 and serves as the basis for the rule, 10 CFR 50.48(c). The NRC-RES and Electric Power Research Institute (EPRI) under a Memorandum of Understanding (MOU) have provided much of the technical basis for this implementation by developing tools critical to performing fire PRA and performance-based fire risk assessments. RES is conducting these activities at the request of a formal NRR User Need letter.

RES began a joint project in early 2008 with EPRI and National Institute of Standards and Technology (NIST) to provide guidance to users of mathematical fire modeling computer codes for nuclear power plant applications. This guidance will help ensure consistent and appropriate application of fire modeling tools used in fire PRAs for NFPA 805 license transitions and other licensing and inspection actions. A draft NUREG report was submitted for peer review in August 2009 and is planned to be issued for public comment by the end of 2009. The final report will be issued in early 2010

In order to address the need for qualified fire PRA practitioners, RES and EPRI have scheduled a detailed, hands-on fire PRA training course in October 2009. This training is based upon the jointly developed document, NUREG/CR-6850 (EPRI 1011989) "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities," and will be very similar to the trainings offered by RES and EPRI in 2007, 2008, and earlier in 2009. Approximately 170 representatives from NRC (NRR, RES, and the Regions), and industry, as well as from foreign countries attended this concentrated training in 2008. These participants provided highly favorable feedback on the training. RES and EPRI had previously conducted more general fire PRA workshops in 2005 and 2006, and the latest detailed training is being provided at the request of both internal and external stakeholders who attended the joint workshops.

RES also supported NRR by participating in the staff audit of the fire PRAs performed by the two pilot plants transitioning to 10 CFR 50.48(c). In these audits, the staff evaluated the conformance of pilots' fire PRAs to the fire portion of the ASME/ANS PRA Standard. RES has also provided support to NRR by attending earlier observation visits to these two pilot plants, by reviewing technical materials for those plants' transition, and by supporting the resolution to fire PRA frequently-asked-questions (FAQs) program. RES' role in these visits and reviews is to ensure that its technical documents are implemented properly, as well as to collect insights relevant to these technologies. RES

is continues to support the ongoing FAQ program, particularly to resolve those fire PRA FAQs submitted by EPRI under the joint MOU between RES and EPRI.

RES issued Revision 2 of R.G. 1.200 in March of 2009. This regulatory guide documented the staff's position on the fire PRA portion of the ASME/ANS PRA Standard and on the NEI Fire PRA Peer Review Guidance. The ASME/ANS PRA standard is a part of the Commission's phased approach to PRA quality (SECY-04-0118), and will support implementation of the risk-informed, performance-based rule endorsing NFPA 805. The fire PRA Standard was originally developed under the auspices of the American Nuclear Society (ANS), but has been integrated into the combined ASME/ANS PRA standard. Previously, RES provided substantial support to the Committee for drafting and reviewing the Standard.

RES is working jointly with EPRI to develop detailed guidance for performing quantitative human reliability analysis (HRA) for post-fire mitigative human actions modeled in a fire PRA. This guidance will build upon the existing information in NUREG/CR-6850 (EPRI 1011989) and take into account the combined ASME/ANS PRA standard identified above. A draft document for public comment is planned for release by Fall 2009. An overview of this work was presented at the June 2009 joint RES/EPRI Fire PRA to encourage public comment.

RES is supporting the NRR Circuit Analysis Resolution Program. RES performed the testing and provided the technical basis for RIS 2004-03 Bin 2 items. This RIS identified circuit issues to be inspected and other lower risk issues that possibly should be subjected to inspection but which needed additional tests and analyses for final determination. RES provided these additional tests and analyses with the Cable Response to Live Fire (CAROLFIRE) program, which was performed in CY 2006 and published as the three-volume NUREG/CR-6931 in April, 2008.

RES will continue to provide support to the NRR Circuit Analysis Resolution Program by conducting direct current (DC) circuit testing in collaboration with EPRI beginning in early CY2009. This testing was requested by NRR as a result of the limited number of DC circuit tests performed by Duke Energy in 2006, which indicated there is a potential for DC circuits to respond differently than AC circuits to the hot short phenomenon. Several DC circuits in NPPs are of high risk significance and their unintended spurious operation resulting from fire damaged cable may play a significant impact on the plants' ability of achieving safe shutdown conditions. The principle purpose of this project is to determine the risk significance of DC circuits by conducting appropriate fire tests. The testing will provide a comparison of DC circuit failure likelihood relative to that of the AC circuits previously tested.

Probability values relevant to circuit analyses will be developed from this AC and DC testing and analysis program. These values will be developed during an expert elicitation and Phenomena Identification and Ranking Table (PIRT) project, sponsored by RES and to be conducted in CY2010. These advancements will be incorporated into the Fire PRA process, helping to reduce the uncertainty of predicting cable failure in fire PRA applications.

RES in collaboration with EPRI has also initiated an update to the EPRI fire events database which was used in the development of NUREG/CR-6850. Data for fires occurring from 2001 to 2008 is being added to the database and more current fire ignition frequencies established as identified in a fire NFPA 805 PRA frequently-asked-question (FAQ). RES and EPRI have planned for a joint report in CY2010 on this project. Furthermore, RES is evaluating fire protection metrics on 10CFR50.72/73 reportable fires and on fire protection findings, and will be issuing a report in September 2009. Reports will be issued every six months to account for new events and findings.

As a part of its "knowledge management" activities, RES has issued a brochure presenting the history of NRC's fire safety research (NUREG/BR-0364), a brochure compiling facts and analyses related to the 1975 fire at the Browns Ferry Nuclear (BFN) Power Plant (NUREG/BR-0361), and is developing a brochure about the history of fire-related rules and regulations. The fire safety research brochure covers the time period (1975-2008) when NRC was transforming fire regulation from a "deterministic" (non-quantitative) system to the present "risk-informed" (more quantitative) system. The BFN brochure preserves the history and impact of the BFN fire on fire regulations to educate future generations of fire safety professionals. The history of fire-related rules and regulations brochure will share over 30 years of regulatory and scientific knowledge with our inspectors, licensees, reviewers, and other interested stakeholders, including fire related documents such as NUREGs, inspection procedures, generic letters, and information notices.

RES has prepared a draft NUREG series report that documents the history, issues and regulatory footprint and site specific use of electric raceway fire barrier systems in NPPs. The reports consolidates documentation regarding all know raceway fire barrier systems including their effectiveness, information regarding the fire endurance testing of the systems, and how the NRC achieved closure for any related open issues. This NUREG series report is a complement to the GAO report issued in June 2008 titled, "Nuclear Safety – NRC's Oversight of Fire Protection at U.S. Commercial Nuclear Reactor Units Could Be Strengthened, GAO-08-0747."

Selected Major Milestones and Schedules				
Major Milestones	**Original Target Date**	**Revised Date**	**Completion Date**	**NRC Responsibility**
Publish report on fire risk requantification, NUREG/CR-6850 (contingent on EPRI)	September 2005		September 2005	RES/DRASP
Issue draft NUREG-1824 for public comment period	October 2005		January 2006	RES/DRASP
Issue draft ANS fire PRA standard for public comment	September 2005	June 2006	April 2006	RES/DRASP
Conduct RES/EPRI fire PRA workshop	June 2006		May 2006	RES/DRASP
Conduct RES/EPRI detailed fire PRA course (2 sessions)	August 2007		July 2007 August 2007	RES/DFERR
Issue Final fire model verification and validation report NUREG-1824	January 2007		May 2007	RES/DRASP
Publish final CAROLFIRE NUREG/CR reports	March 2008	April 2008	April 2008	RES/DRA
Issue fire portion of R.G. 1.200 for public review and comment (Done as a part of Rev. 2 of R.G. 1.200)	June 2008		June 2008	RES/DRA
Conduct second RES/EPRI detailed fire PRA course (2 sessions)	November 2008		November 2008	RES/DRA
Issue draft Fire HRA guidance for public comment	November 2008	September 2009		RES/DRA
Issue draft fire model users guide	February 2009	November 2009		RES/DRA
Issue fire portion of R.G. 1.200, rev 2.	March 2009		March 2009	RES/DRA

Issue final NUREG/CR on DC circuit testing results	June 2010			RES/DRA
Incorporate CAROLFIRE and DC circuit results into Fire PRA process	December 2010			RES/DRA
Issue Electric Raceway Fire Barrier System NUREG	December 2010			RES/DRA
Support NFPA 805 implementation (e.g. FAQ program)	Ongoing			RES/DRA